

## PRE-COMMISSION CLEANING

Installations (boilers, heat exchangers, cooling water systems etc.) are often cleaned prior to being put into use. This procedure is called pre-commission cleaning. Various procedures carried out on the installation will have resulted in it being contaminated with grease/oil, welding scale etc. The temporary protective layer of the steel will moreover have been corroded resulting in (fly) rust. There are various methods for removing these types of contamination chemically. The method chosen will depend on, in addition to the technical aspects (from which materials has the system been constructed and the extent to which the system is contaminated), the requirements of the customer. The proper assessment of which cleaning method to apply and the subsequent implementation of it requires expertise.

This bulletin restricts its attention to the cleaning of installations constructed from carbon steel (C-steel) and the various cleaning methods that Vecom is able to perform (on site). Four pre-commission cleaning methods are then discussed in turn.



Pre-commission cleaning with Demclean 94<sup>®</sup>

### INTERMEZZO

In general pre-commission treatment comprises:

#### *Degreasing*

A degreasing step during pre-commission cleaning procedure need not involve (in all cases) strong agents. Not only light oil and grease contamination from processing will be removed, but also atmospheric contamination.

#### *Pickling*

A pickling phase will remove iron oxide (welding scale, when present, too).

#### *Passivation*

The steel surface will after pickling be active, rusting (fly rust) immediately. To counter this the steel is temporarily protected. This can be realized by passivation, a chemical treatment during which a stable gamma- ferric oxide is formed. A standard passivation is conducted in ammonium citrate with an oxidizer.

### Cleaning on the basis of hydrochloric acid

Cleaning with inhibited hydrochloric acid is a method that is frequently employed. Hydrochloric acid will ensure that the material is pickled fully, removing rust welding and mill scale effectively. When in addition to fly rust older rust ( $\text{Fe}_2\text{O}_3$ ) is also present, hydrofluoric acid or another additive is introduced to prevent corrosion by ferric ion ( $\text{Fe}^{3+}$ ). A standard treatment with hydrochloric acid comprises: degreasing, rinsing, pickling, rinsing, passivation. Passivation is conducted with ammonium citrate and an oxidizer forming a (temporary) stable uniform gamma-ferric oxide film. During cleaning large quantities of waste water are released as a result of the intermediate rinse phases. This water can be processed applying the DND principle (Detoxification, Neutralization, Dewatering).

*Advantages:* dissolves mill scale too; very suitable for heavily rusted material; standard procedure (well-known); in some cases the only suitable method.

*Disadvantages:* large quantities of waste water; various corrosive chemicals required; more time consuming; less operator and environmentally friendly; when improperly applied risk of damaging base material.



### Cleaning on the basis of citric acid

Cleaning with inhibited citric acid is conducted at a neutral pH. High temperatures are required however to remove the iron oxides. At elevated temperatures citric acid becomes more corrosive despite the neutral pH and inhibitors are required that may interfere with the second phase of the cleaning, passivation. Citric acid forms with iron a strong complex and the solution can be made alkaline without the iron precipitating as hydroxide. This means that with citric acid pickling and passivation can be conducted with one solution. When passivating hydrogen peroxide or sodium nitrite is generally dosed. After cleaning waste water is released that can be processed in a straightforward fashion by biological waste water purification or by the DND method.

*Advantages:* passivation with the cleaning solution; less waste water; method is suitable for removing copper.

*Disadvantages:* high operating temperatures; unable to remove mill scale; addition of chemicals during the passivation phase.

### Cleaning on the basis of EDTA, Demclean 94®

The Demclean 94® cleaning method is based on EDTA in pH neutral media (see also TB 2004-06 of March 2004). This method removes, not only iron oxides, but also light oil, grease and atmospheric contamination. The rust (iron oxides) is dissolved with the formation of a strong iron-EDTA complex. This allows the pH to be increased after cleaning without the iron precipitating as ferric hydroxide. After this neutralization the steel is passivated by dosing sodium nitrite. This means that only one solution is required for pickling and passivation with less waste water being released. The waste water released by this cleaning procedure may be treated by biological water purification modified for EDTA processing.

*Advantages:* pH neutral cleaning agent; passivation with the cleaning solution; less waste water; not corrosive for other metals; time saving.

*Disadvantages:* addition of chemicals during the passivation phase; unable to remove mill scale; limited capacity for dissolving iron.

### Cleaning on the basis of VPX One Step®

The VPX One Step® process developed by Vecom consists of a cleaning procedure with a pH neutral solution, which dissolves the iron oxide allowing the underlying steel substrate to be phosphated. This process therefore pickles and passivates in one step. The fact that no other cleaning solution or addition of chemicals is required in order to passivate is a major advantage because fewer environmentally harmful substances are used. VPX One Step® contains moreover no toxic/corrosive constituents making this chemical cleaning procedure very environmentally and operator friendly. The waste phase is also free of problems. The waste water can be simply treated by the DND method. After cleaning a rinse phase is applied in which the waste released has a volume of twice the capacity.

VPX One Step® will, thanks to its neutral pH, cause no problems when the installation in addition to carbon steel incorporates also other metals such as copper, aluminium, zinc or stainless steel. VPX One Step® barely reacts with these metals, nor does it give rise to plating. VPX One Step® cannot be used to remove mill scale. A pre-treatment with hydrochloric acid should be used for that purpose.

*Advantages:* neutral; pickling and passivation in one step; operator and environmentally friendly; no reaction with other metals; fits in well with the boiler water treatment programme due to the presence of a phosphate film.

*Disadvantages:* process is not accepted worldwide; does not remove mill scale; removes with difficulty very severe rust; not cheap.



Pre-commission cleaning of a heat exchanger using VPX One Step®

You will find on the next page a table with the various pre-commission cleaning methods.

Table : Review of the various pre-commission cleaning methods

	<b>Demclean 94®</b>	<b>Hydrochloric acid</b>	<b>Citric acid</b>	<b>VPX One Step®</b>
Water consumption during cleaning	1 X system capacity	pickling 1 X rinsing 2 X passivation 1 X total 4 X capacity	1 X system	pickling/passivation 1 X rinsing 1 X total 2 X capacity
pH cleaning solution	neutral (5,0 - 5,5)	acidic ( < 1)	acidic (3,0 -3,5)	neutral (6,0 - 6,5)
Operating temperature °C	50-60	40-50	70-80	40-50
Cleaning time (hrs)	24	48	24	15
Effluent treatment	Biological	DND	DND/Biological	DND
Corrosive constituents during pickling phase	none	yes, hydrochloric acid	yes, citric acid	none
Pickling	iron oxides (rust) and very light grease/atmospheric contamination	iron oxides (rust) and mill and annealing skin	iron oxides (rust)	iron oxides (rust)
Passivation / passivation solution	After NH <sub>3</sub> neutralization with nitrite  1 step	After rinsing with ammonium citrate / peroxide  2 steps	After NH <sub>3</sub> neutralization with H <sub>2</sub> O <sub>2</sub>  1 step	No extra dosing required. Passivation by phosphate formation.
Maximum iron concentration	4 g/l	10 g/l	10 g/l	7 g/l
Cleaning possible, when copper oxides are present	No	Yes, with modification copper removal procedure	Yes, with modification copper removal procedure	No
Cleaning possible when pipes present of:				
Copper	No	No	No	Yes
Stainless steel	Yes	No	Yes	Yes
Accepted worldwide	Yes	Yes	Yes	No

You will find Vecom in **the Netherlands** (Maassluis, Rotterdam, Bergen op Zoom, Heerlen, Enschede, HoogeZand) - **Belgium** (Ranst, Mouscron) - **Germany** (Hamburg, Wetzlar) - **United Kingdom** (Bury, Barnsley, Sheffield) and **Denmark** (Løsning)